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**“Reality and Potential of Food Security and Agricultural Diversification in
Small Island Developing States”**

**“Realidad y Potencial de la Seguridad Alimentaria y la Diversificación
Agrícola en Pequeños Estados Insulares en Desarrollo”**

**“Sécurité alimentaire et diversification agricole dans les petits états
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HUMAN MOVEMENT AS A PATHWAY FOR THE MOVEMENT OF EXOTIC PLANT PESTS INTO AND WITHIN THE GREATER CARIBBEAN REGION

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ABSTRACT: People moving between areas may contribute to the spread of plant pests by inadvertently carrying the pest on themselves, by transporting the pest on objects such as handicrafts, or by intentionally collecting and moving the pest. Visitors to the Greater Caribbean Region (GCR), the most heavily visited region in the world, arrive by air, water, or land, with air travel being predominant. Once in the GCR, visitors frequently move between countries. Cruise ship, ferry, and small boat passengers and people crossing land borders are often not subject to phytosanitary inspections. Inspection of airline passenger baggage is common, but cannot do justice to the ever-increasing passenger volume. The obvious potential of humans to facilitate pest spread, the immense number of travelers into and within the GCR, and an overall insufficient level of phytosanitary safeguards warrant that the pest risk associated with this pathway be considered very high. This work was carried out in the framework of the CISWG Caribbean Pathway Analysis. The complete report can be accessed at: <http://carribbean-doc.ncsu.edu/index.htm>.

Keywords: pathway analysis, tourism, invasive species, interception

INTRODUCTION

The introduction of pests into new locations has been closely linked to the movement of humans. Persons visiting an area may intentionally or unintentionally spread plant pests in several different ways: They may be carrying the pest on themselves, their clothing, or their shoes; they may unintentionally transport the pest on products such as handicrafts (Image 1) or plant parts; or they may deliberately collect the pest (e.g., insects, snails, seeds, or whole plants) to take it to a different location.

As the most heavily visited tourist region in the world (Padilla and McElroy, 2005), the Greater Caribbean Region (GCR)¹¹ is faced with the challenge of managing this risk of exotic pest introduction. In the insular Caribbean, the travel industry is among the most important industries, comprising almost 15% of the Gross Domestic Product (GDP) (WTTC, 2008). In 2006, international tourist arrivals numbered 19.4 million, 7 million, and 18.7 million for the Caribbean islands, Central America, and South America, respectively (UNWTO, 2008). The United States provided the largest source of tourists traveling to the insular Caribbean, with well over five million arrivals (CTO, 2007).

Travelers arrive by one of three basic modes: air, water, or land. Most travelers arrive by air (UNWTO, 2006). Cruise ships, departing mainly from North America, also bring a substantial number of visitors into the GCR (FCCA, 2008). Travelers may arrive by water on ferries or on personal or chartered boats. Access across land borders is possible in North, Central, and South America as well as on the islands of Hispaniola and Saint Martin. Once in the GCR, tourists often move between countries ("island-hop") by regional flight, small boat, ferry, or cruise ship. We address each basic mode of human movement into and within the GCR and discuss the potential of each to serve as pathways for exotic pest introduction.

¹¹ All countries bordering the Caribbean Sea, plus the Bahamas, Turks and Caicos, El Salvador, Suriname, Guyana, and the U.S. Gulf States.

PATHWAY: AIR TRAVEL

The Caribbean's tourism industry is largely dependent on air transportation (Bertrand, 2007). Annually, over 19 million visitors arrive in Caribbean countries by airplane¹² (UNWTO, 2008). The level of agricultural inspection of airline passenger baggage varies among Caribbean countries and among airports within the same country. In Martinique, flights originating in France are not inspected (Ferguson and Schwartzburg, 2008). Flights between the islands of Trinidad and Tobago are not subject to agricultural inspections (Bertone and Gutierrez, 2008). In the United States, agricultural inspections are routine, but the level of scrutiny varies between flights. In some cases, inspection levels have not been able to keep up with growing passenger numbers. From 2005 to 2007, the number of passengers traveling from Aguadilla, Mayagüez, and Ponce, Puerto Rico, to the U.S. mainland increased by 65%, whereas the number of passengers inspected grew by only 50% (USDA-APHIS-PPQ, 2008b). Travelers from the U.S. mainland to Puerto Rico or the U.S. Virgin Islands are not subject to agricultural inspections. Regarding airline passenger baggage, it may therefore be more likely for pests to be carried from the U.S. mainland to the Caribbean rather than the other way around.

In 2007, baggage inspections at airports in U.S. states located in the GCR (Florida, Alabama, Louisiana, Mississippi, and Texas) resulted in 126,136 plant quarantine material interceptions, 374 soil interceptions (USDA, 2008b), and 4,049 pest interceptions (3,620 of them U.S. quarantine pests) (USDA, 2008a). The tropical grey chaff scale (*Parlatoria cinerea*), citrus canker (*Xanthomonas axonopodis* pv. *citri*), and Medfly (*Ceratitidis capitata*) were repeatedly intercepted (USDA, 2008a). Almost 4% of international air passenger groups arriving in the U.S. had plant quarantine materials in their luggage. We estimated that three quarters of these materials routinely escape detection (Meissner et al., 2009).

PATHWAY: CRUISE SHIPS

Over 10 million cruise passengers departed from North America in 2007. Almost half of all North American cruise itineraries include the Caribbean (FCCA, 2008). Similar to airline passengers, cruise ship passengers have the potential to carry weed seeds, plant pathogens, or small insects on their shoes or clothing. The majority of multi-destination visitors in the Caribbean are cruise passengers (Garraway, 2006). Because these visits to climatically similar destinations occur within a short time frame, cruise passengers may carry viable plant pests to a new location that is suitable for survival of the pest, especially with current trends (e.g., ecotourism, private island experience) leading to visitation of more natural and pristine areas. Passengers are also likely to visit local markets where they may buy handicrafts or other items that could harbor plant pests.

Inspection procedures for cruise ship passengers vary among GCR countries. In the United States, rules state, "passengers and baggage on cruise ships with Caribbean, Mexico or Bermuda itineraries are not routinely inspected" (USDA-APHIS-PPQ, 2008a). The ports of Quetzal and San José, Guatemala, receive over 50 cruise ships per year. Passenger baggage is not inspected. Inspections performed on hulls, food provisions, and garbage usually result in no quarantine material detections (Meissner and Schwartzburg, 2008). Cruise ships often dock in Fort-de-France, Martinique, for a few hours' stay, and passengers are not subject to agricultural inspection at arrival or departure (Ferguson and Schwartzburg, 2008).

A short, intensive data collection effort in 2007 targeting the red palm mite, *Raoiella indica*, led to over 30 pest interceptions on cruise ship baggage at Florida ports (USDA, 2008a) (interception records summarized in Table 1). Almost all of these interceptions were on leaves of the coconut palm (presumably handicrafts). As cruise ship passengers and baggage are not routinely inspected at many ports in the GCR, most of these pests would be missed.

¹² This number is based on international tourist arrivals. Tourists are visitors staying more than 24 hours.

PATHWAY: SMALL VESSELS

Private yachts and small commercial vessels travel constantly between nations of the GCR (Pattullo, 1996) and nearby countries. The exact number of vessels is difficult to quantify since this data is not typically collected. In many cases, inspection of these vessels is not feasible, and private vessels often return to marinas and private docks without any contact with an agricultural inspector. For example, at the Marina Puerto del Rey in Puerto Rico, the largest private marina in the Caribbean, arriving vessels are often cleared by radio and are not boarded by an inspector (Ruiz, 2007). The same is true in Florida (Lemay et al., 2008), Guatemala (Meissner and Schwartzburg, 2008), and presumably in other locations throughout the Caribbean.

Visitors traveling by yacht depend on local markets for provisions, and farmers regularly supply agricultural products directly to sailors at marinas (Pattullo, 1996). Small vessels often carry agricultural commodities and/or propagative material intended for personal use or for small-scale trading (Boerne, 1999; Ferguson and Schwartzburg, 2008). *Mycospharella fijiensis*, the causal agent of black Sigatoka disease, is believed to have entered Trinidad via this pathway, and there is concern that *Moniliophthora roreri*, the causal agent of frosty pod of cocoa, may spread in the same manner (Bertone and Gutierrez, 2008). Pests in association with plants and propagative material will have the best chance of surviving in their new environment. Therefore, this pathway is of great concern.

PATHWAY: FERRIES

Ferries are an important means of transportation in the GCR. A regular ferry service operates between Belize and both Honduras and Guatemala (Travour.com, 2008) as well as between the islands of Trinidad and Tobago. Ferries and high-speed catamarans travel frequently between Martinique, St. Lucia, Barbados, Dominica, St. Vincent, and Guadeloupe, and there is potential for movement of plant products via this pathway. Catamaran passenger baggage in Martinique is randomly selected for agricultural inspection twice a month (Ferguson and Schwartzburg, 2008), but in many other places, ferry passengers are not subjected to any agricultural inspection, thus leaving this pathway largely unmitigated.

The ferry Caribbean Express carried 145,000 passengers, 16,000 vehicles, and 13,000 containers between Puerto Rico and the Dominican Republic in 2006 (Dominican Today, 2007). In a blitz operation in April 2007, a total of 2,071 passengers and 198 personal vehicles were inspected over the course of three days, resulting in 68 plant quarantine material and seven pest interceptions (Caribbean Risk Assessment Group, 2008). Assuming that the inspections detected all quarantine material and all pest present, this would translate into about 5,000 plant quarantine material and 500 pests per year arriving in Puerto Rico via Caribbean Express (not counting the cargo containers). Only a fraction of these pests would be intercepted by routine agricultural inspections. A number of exotic pests established in Puerto Rico are believed to have originated in the Dominican Republic (Caribbean Risk Assessment Group, 2008), and almost any pest may potentially be carried by ferry passengers. This pathway should thus be considered high risk, a conclusion which was also reached by the Caribbean Risk Assessment Group.

PATHWAY: LAND BORDERS

In the Insular Caribbean, the islands of Hispaniola and Saint Martin are home to more than one country and can be accessed via land borders. All of the Central and South American countries in the GCR share land borders with at least two other countries. Many of these countries informally trade agricultural products and handicrafts. Traders, agricultural day workers, and tourists routinely cross land borders. Daily, several hundred Haitians (mainly migrant workers) cross the border into the Dominican Republic (CIA, 2008; Navarro, 1999). The people of Mexico and Guatemala actively trade basic agricultural items and handicrafts (Núñez, 2007). A large number of people, many of them migrant farm workers, also move routinely

between Costa Rica and Nicaragua. The Costa Rican Department of Agriculture (MAG), working closely with other agencies, inspects vehicles and pedestrians and frequently intercepts agricultural quarantine materials. The coffee berry borer, *Hypothenemus hampei*, a serious agricultural pest, is believed to have been inadvertently introduced into Costa Rica by pedestrians crossing the border from Nicaragua in 1983 (Bertone and Meissner, 2008).

Much of the movement of people occurs at unofficial (unstaffed) border crossings. For example, between Mexico and Guatemala, about 36 border crossings have been identified; however, only eight of them are regulated (Solís, 2005). Temporary workers who enter Guatemala through official ports of entry are subject to agricultural inspections, yet many enter at unstaffed crossings. There is speculation that workers also enter Belize through unstaffed docks with infested fruit fly host material, thus introducing the unwanted Medfly and prompting emergency eradication efforts (Caniz, 2008). Even at many official crossings, no agricultural inspection takes place. Throughout Central America, inspections at land borders are generally limited to immigration and customs checks (Caniz, 2008).

Starting in the 1980s, Central America became a geographic bridge to North America for migrants from South America seeking to enter the United States (Mahler and Ugrina, 2006). In terms of pest risk, this may mean that the flow of pest introductions due to human movement across land borders may follow a northern course, with pests from South America moving into Central America and North America, and pests from Central America moving into North America.

CONCLUSIONS

Pest interception data related to human movement into or within the GCR is scarce; however, it is obvious that the number of travelers is immense. Most travelers arrive by air, but small vessels and cruise ships also carry large numbers of people. Movement across land borders in the GCR is not well documented and is often overlooked; however, the associated pest risk may be considerable. The same is true for movement of yachts and other small vessels. For all modes of travel, the level of phytosanitary inspection is generally insufficient to mitigate pest risk.

SUGGESTIONS FOR IMPROVED SAFEGUARDING

- Launch a Caribbean-wide educational campaign on the potential ecological and economic consequences of exotic species introduction.
- Educate visitors to natural and agricultural areas about prevention of exotic pests.
- Implement a user fee system for eco-tourist sites to raise funds for prevention and management of exotic species.
- Limit access to sensitive natural areas.
- Implement sanitation practices (e.g., washing of shoes, checking clothes for seeds, etc.) at natural and agricultural sites visited by tourists.
- Raise money for exotic pest prevention and for exclusion efforts by selling educational products (e.g., postcards, calendars, souvenirs, etc.) to tourists.
- Increase presence and visibility of agricultural inspectors, and publicize interceptions to deter potential violators.

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Table 1. Pest interceptions on maritime (primarily cruise ship) baggage at Florida ports during 2007. The number of specimens intercepted is listed after the pest's name. Note: These interceptions were the result of a special data collection effort targeting the red palm mite, *Raoiella indica* (USDA, 2008a).

Pest	Origin
Insects	
<i>Hoplandrothrips flavipes</i> (Phlaeothripidae): 13	Jamaica
Aleurodicinae species (Aleyrodidae): 8	Mexico
<i>Aleurotrachelus atratus</i> (Aleyrodidae): 1	Unknown
<i>Aonidiella orientalis</i> (Diaspididae): 1	St. Maarten
<i>Gryllus</i> sp. (Gryllidae): 1	Unknown
<i>Hemiberlesia lataniae</i> (Diaspididae): 1	Mexico
<i>Hoplandrothrips flavipes</i> (Phlaeothripidae): 1	Mexico
<i>Resseliella</i> sp. (Cecidomyiidae): 37	Dominican Republic
Mites	
Ameroseiidae species: 2	Jamaica
<i>Aonidiella orientalis</i> (Diaspididae): 2	Unknown
Macrochelidae species: 1	Jamaica
Mesostigmata species: 10	Haiti
<i>Oligonychus</i> sp. (Tetranychidae): 1	Puerto Rico
Oribatida species: 2	Jamaica
Parasitidae species: 2	Jamaica
<i>Raoiella indica</i> (Tenuipalpidae): 100	St. Maarten, Dominican Republic, and
Tenuipalpidae species: 6	Puerto Rico
<i>Tetranychus</i> sp. (Tetranychidae): 4	St. Maarten and unknown origin
<i>Tyrophagus</i> sp. (Acaridae): 2	Jamaica
Weeds	
<i>Sorghum</i> sp. (Poaceae): 1	Unknown



Image 1. Handicrafts made of palm leaves for sale in Puerto Rico. These items have the potential to harbor plant pests, as evidenced by the detection of live red palm mites, *Raoiella indica*, in palm frond hats made in the Dominican Republic and brought by cruise ship passengers to Palm Beach, Florida (Apgar, 2007; Welbourn, 2007).

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